

Kentucky Watershed Priority Formula: Application Guidelines and Data Requirements

L. Ormsbee
L. Colten

The Kentucky Division of Water
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ABSTRACT

This report presents a methodology for ranking and selecting individual 11-digit HUCs for subsequent development of detailed watershed management plans as part of the Kentucky Watershed Management Framework. The proposed methodology consists of two phases: 1) Prioritization and 2) Targeting. The prioritization phase is used to rank 11-digit HUCs on the basis of existing special protection areas and the existence or potential existence of designated use impairment. The prioritization is accomplished using a priority watershed formula developed especially for this purpose. The formula is intended to serve as an objective tool for compiling environmental indicators to rank watersheds and for use in deciding how to allocate resources to address both protection and restoration goals as part of the Kentucky Watershed Management Framework objectives. The targeting phase involves determining the feasibility of a particular project. Targeting criteria include: public support, manageability, data availability, program-specific funding, program constraints, and watershed goals. By cross-referencing the prioritization score and the targeting score for all watersheds a classification matrix may be constructed which can serve to provide guidance for the type of management activity appropriate for each individual watershed.

TABLE OF CONTENTS

I.	INTRODUCTION	1
1.1	Background	1
1.2	Framework Components	1
1.2.1	Basin Management Units	1
1.2.2	Basin Management Schedule	1
1.2.3	Basin Management Cycle	3
	1.2.3.1 Scoping and Data Gathering	4
	1.2.3.2 Assessment	4
	1.2.3.3 Prioritization and Targeting	4
	1.2.3.4 Plan Development	4
	1.2.3.5 Implementation	4
1.3	Watershed Priority Formula	5
1.3.1	Formula Assumptions	5
1.3.2	Protection Score	6
1.3.3	Restoration Score	9
	1.3.3.1 Potential Impacts Score	9
	1.3.3.2 Observed Impacts Score	12
1.3.4	GIS Utilization	12
1.3.5	GIS Coverages	13
1.4	Watershed Targeting	18
1.4.1	Public Support	18
1.4.2	Manageability	18
1.4.3	Data Availability	18
1.4.4	Program-Specific Funding	18
1.4.5	Program Constraints	18
1.4.6	Goals	19
1.5	Classification Matrix	19
	REFERENCES	20
	APPENDIX A: GIS COVERAGE METADATA	
	APPENDIX B: GIS COVERAGE CONSTRUCTION GUIDELINES	

INTRODUCTION

1.1 Background

As part of a national EPA initiative, the Kentucky Division of Water (KDOW) has embarked on the development and coordination of a comprehensive watershed framework for use in managing and preserving the water resources of Kentucky. The purpose of the framework is to provide a means for coordinating and integrating the programs, tools, and resources of multiple stakeholder groups to better protect, maintain, and restore the ecological structure and function of watersheds as well as support the sustainable uses of watersheds. In contrast to a strict regulatory approach, the proposed framework employs a resource-centered approach. Success is measured in terms of maintaining and improving environmental quality and protecting public health by fostering the protection and restoration of specific resource uses, such as drinking water supply, aquatic and wild life habitat and propagation, and recreation, while sustaining economic activities that depend on natural resources (KDOW, 1997).

1.2 Framework Components

The proposed framework includes five basic components: 1) basin management units, 2) a basin management cycle, 3) a statewide basin management schedule, 4) a partner network and public participation, and 5) basin and watershed management plans.

1.2.1 Basin Management Units

In order to facilitate the application of the watershed management approach across the Commonwealth, the state of Kentucky has been subdivided into 5 basin management units. The basin management units are based on 6-digit hydrologic unit codes (HUCs), within which are nested 8, 11, and 14-digit HUCs (watersheds). HUCs were developed by the U.S. Geological Survey (USGS), the U.S. Department of Agriculture's Natural Resources Conservation Service, and others, to standardize hydrologic unit delineations for geographic description and data storage purposes. A map of the five basin management units is provided in Figure 1. A listing of the five basin management units and their associated statistics is provided in Table 1.

1.2.2 Basin Management Schedule

In applying a watershed management approach across the state, each basin management unit will be processed through a five part basin management cycle. In order to provide for the strategic utilization of program resources, the basin management cycle for each basin management unit will be lagged by one year, and sequenced over a five year period.

Table 1. Basin Management Units for the Kentucky Watershed Framework.

Basin Management Unit Number and Description	No. of USGS 8-digit HUCs	Area (sq.mi.)	Percent of Total State Area
1. Kentucky River	5	6,966	17.2
2. Salt and Licking Rivers	8	9,037	22.4
3. Upper and Lower Cumberland, Tennessee, and Mississippi Rivers	15	9,853	24.4
4. Green and Tradewater Rivers	12	11,109	27.5
5. Big Sandy, Little Sandy, and Tygarts	6	3,424	8.5

1.2.3 Basin Management Cycle

Kentucky's basin management cycle has five activity phases that are sequenced and repeated for each basin management unit at fixed 5-year intervals to ensure that management goals, priorities, and implementation strategies are routinely updated and progressively implemented (Figure 2). A brief discussion of each activity is provided in the following sections (KDOW, 1997).

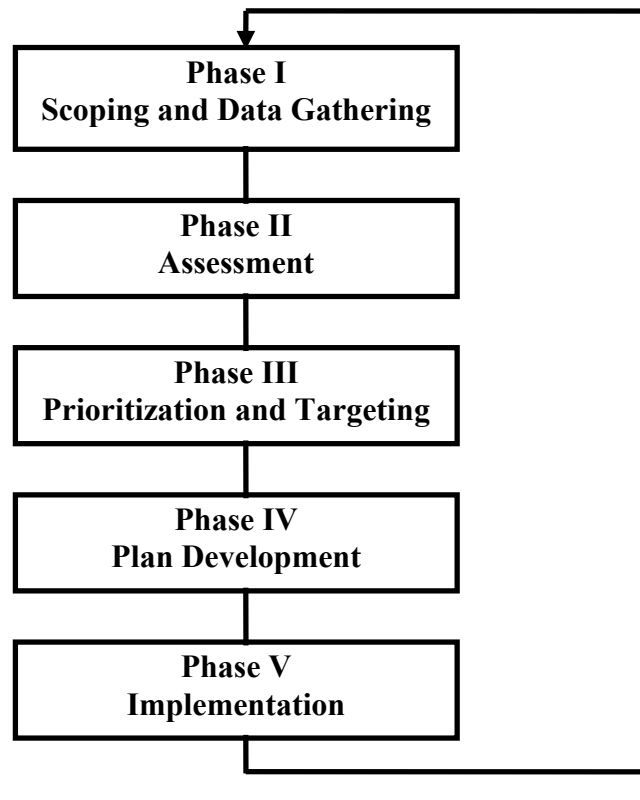


Figure 2. Basin Management Cycle

1.2.3.1 Scoping and Data Gathering

This phase involves the development of a “Basin Status Report” for the purpose of documenting the baseline conditions of the basin management unit. Interested partners will then develop and implement a strategic data collection plan that clarifies the purposes for collecting information, identifies what can be accomplished with the resources available and outlines complementary roles and responsibilities (KDOW, 1997).

1.2.3.2 Assessment

During the second phase, quantitative and qualitative analyses will be performed to evaluate and document the severity, causes, and sources of stress to watershed resources. The 11-digit scale watershed has been selected as the basic unit for assessment. Key summaries of partners’ assessments are then compiled to update the “Basin Status Report” and provide the basis for ranking management priorities and targeting stakeholder resources for management strategy development. Written basin summaries will be organized by 6-digit HUCs while prioritized Watershed Management Plans will be developed for targeted 11-digit HUCs (KDOW, 1997).

1.2.3.3 Prioritization and Targeting

In the third phase, framework partners and other interested stakeholders will work together to select those 11-digit watersheds for subsequent management plan development. The 11-digit HUCs will be selected on the basis of a two step process: 1) Prioritization and 2) Targeting. Priorities will be determined based primarily on technical factors related to resource impairment (i.e. severity of impacts, spatial scale or extent of impact) and threat to watershed resources (considering scale and immediacy of threats, and special protection status of certain resources). Targeted watersheds will be identified based on technical feasibility, political feasibility, cost-effectiveness, and programmatic feasibility (KDOW, 1997).

1.2.3.4 Plan Development

In this phase, technical experts from partner agencies will work with other stakeholders to identify, evaluate, and select management strategies to address targeted priority issues. Implementation strategies will be documented in draft basin and watershed plans that outline specific actions, responsible parties, and funding sources to serve as a guide for framework partners (KDOW, 1997).

1.2.3.5 Implementation

During phase five, framework partners will carry out and guide management actions in accordance with agreed-upon actions plans (KDOW, 1997).

1.3 Watershed Priority Formula

In order to prioritize the 11-digit HUCs for subsequent management plan development, an objective ranking methodology is employed. A priority watershed formula serves as an objective tool of compiling environmental indicators in order to rank watersheds, based on restoration or protection factors. As such, the formula should achieve the following objectives (KDOW, 1997):

1. Summarize existing environmental information (indicators) on watersheds within a large-scale basin for comparative purposes;
2. Highlight information gaps to help guide future data collection efforts;
3. Educate the public about the importance of the resources and the information needed for decision-making; and
4. Serve as an incentive for further information-gathering by governmental and non-governmental stakeholders.

The watershed priority formula is intended to summarize technical information and serve as a basis for deciding how to allocate resources to address two separate goals: 1) protection and 2) restoration. In order to accomplish this objective, the formula has been developed with two separate components: a protection (or vulnerability) component, and a restoration (or severity) component. In generating a score for each 11-digit HUC, the individual 14-digit HUCs that make up the 11-digit HUCs are first evaluated using the priority formula. Once these scores have been obtained they are averaged using a weighted-area approach to yield the score for the associated 11-digit HUC. Mathematically, the composite score for a particular 14-digit HUC will be the product of the two component scores. This may be expressed as follows:

$$\text{14-digit HUC Priority Score} = (\text{Protection Score}) * (\text{Restoration Score})$$

1.3.1 Formula Assumptions

Because of the limitations of any mathematical ranking formula, it is important to understand its implications. Assumptions implied by the formula are:

1. The overall size of a watershed does not affect its ranking relative to another watershed.
2. In calculating the Restoration Score, both existing and potential impacts are considered.
3. In calculating the observed impacts score, human health and ecological health are assumed to be of equal value.
4. In calculating the restoration score, the observed impact score is considered more important than the potential impact score (i.e. it is weighted by a factor of two).

1.3.2 Protection Score

The protection score is used to identify those watersheds which contain areas or streams with special designation resulting in elevated protection status above the minimum standards. These areas are identified by various programs and mandates for extra protection. The protection score for each watershed is computed based on a weighted average of the protection scores for each category. Protection categories include: 1) Wetlands, 2) Surface Drinking Water Protection Area, 3) Well-head Protection Areas, 4) Groundwater Sensitivity Zones, 5) Fish/Wildlife Management Areas, 6) Nature Preserves Management Areas, 7) Nature Conservancy Area, 8) Reference Reach Watersheds, 9) Outstanding Resource Watersheds, 10) Recognized Resources, and 11) River Assessment Categories. Mathematically, this relationship is expressed as:

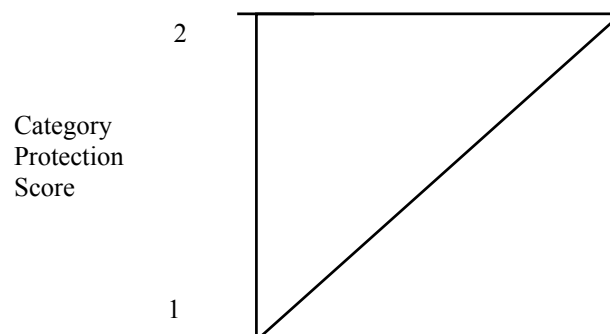
$$\text{Protection Score (PS)} = (a \cdot C1 + b \cdot C2 + c \cdot C3 + \dots + k \cdot C11)$$

where C1 C11 represent the protection scores for each category (i.e. C1 = wetlands protection score) and a, b, ... k are coefficients whose sum is equal to one.

The protection scores for the Recognized Resources and River Assessment categories are themselves based on a weighted average of additional sub-categories. The sub-categories for the Recognized Resources include: 1) Rare Species, 2) National Natural Landmarks, 3) National Parks, 4) Federal Conservation Areas, and 5) University Natural Areas. The sub-categories for the River Assessment category include: 1) Agricultural Lands, 2) Botanical Resources, 3) Corridor Character, 4) Cultural Resources, 5) Fish Resources, 6) Geologic and Scenic Features, 7) Recreational Boating, 8) Water Quality, 9) Water Resources, and 10) Wildlife Resources.

The individual protection scores for each protection category are generated by developing a linear relationship between the category protection score and an associated category indicator score. The category protection score will range from 1 to 2 while the category indicator score limits will be dependent upon the range of the associated category indicator. Example functions for each of the protection categories are shown in Figure 3.

Normalized watershed category indicator scores for each 14-digit watershed are developed by processing the associated category information using a GIS (Geographical Information System; e.g. ArcInfo, ArcView) (see Figure 4). Note: The normalized watershed area score is based on either the actual percent of the total watershed area within a particular protection category (eg. wetlands, fish/wildlife management areas, nature preserves management area, and nature conservancy area) or the tier or level weighted percent area (well-head protection area, groundwater protection zone).



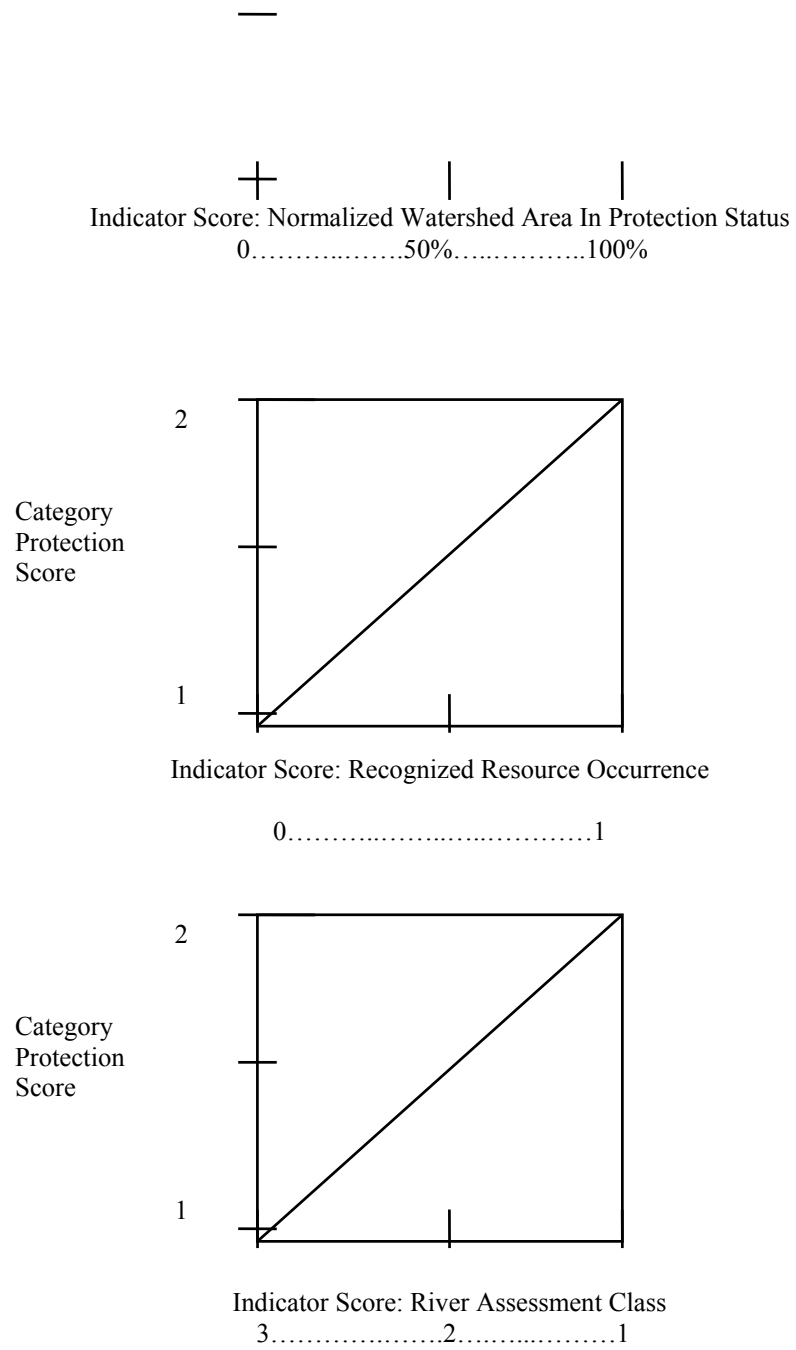
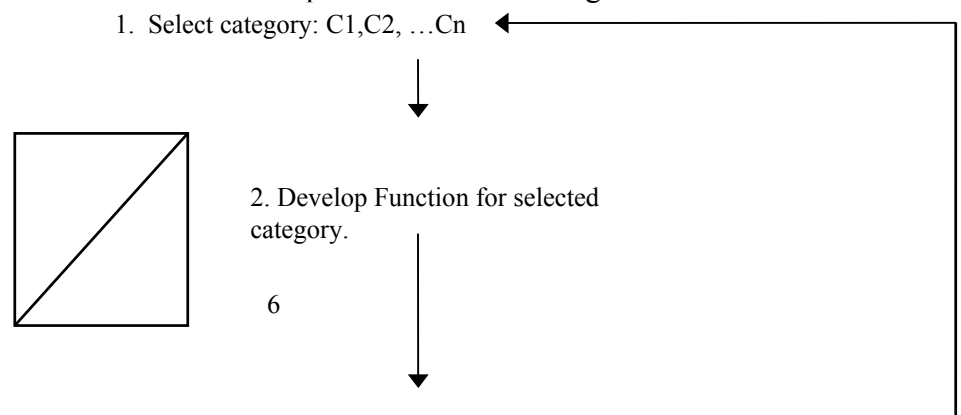


Figure 3. Functional Relationships for Protection Categories



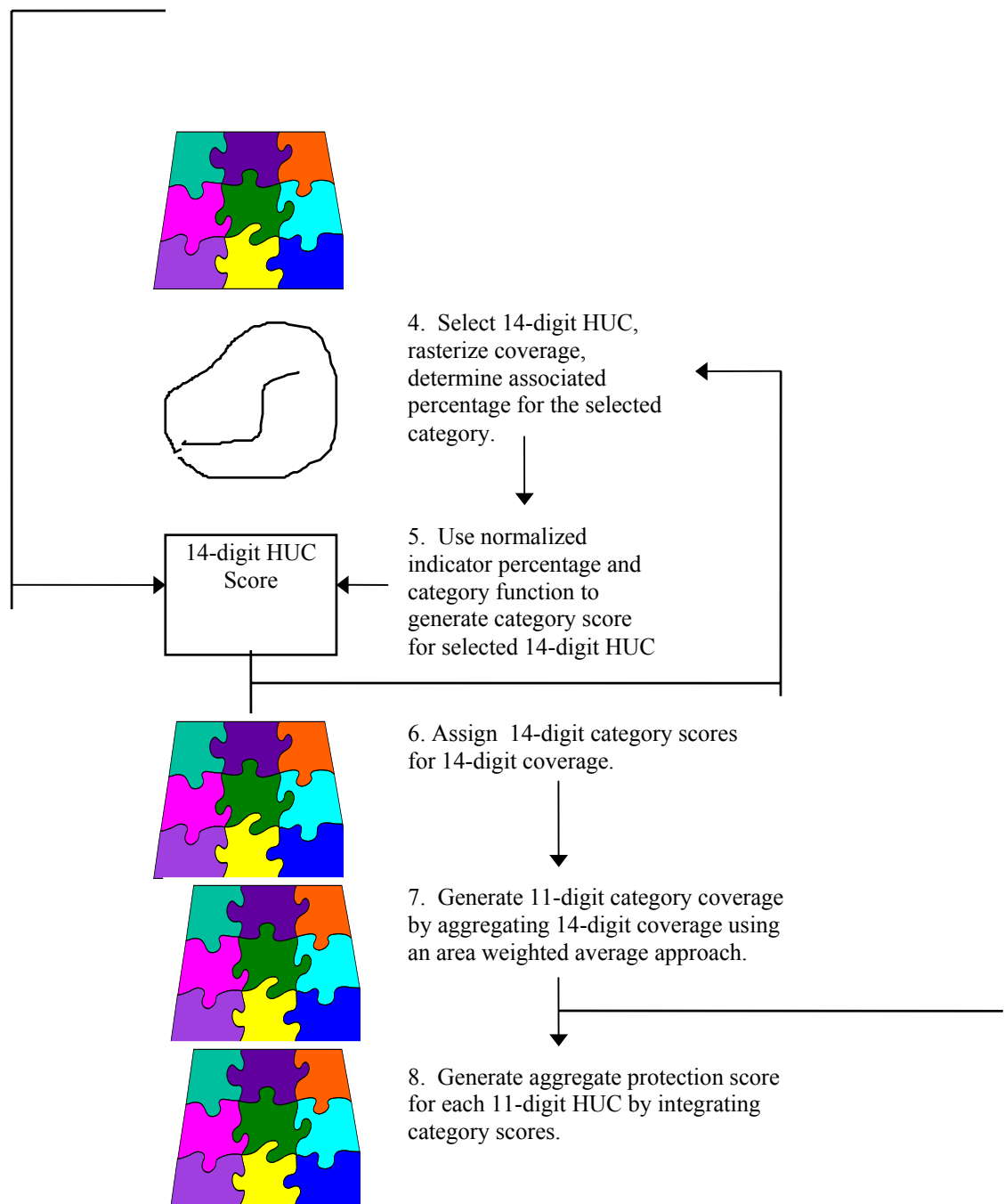


Figure 4. Protection Score Development

1.3.3 Restoration Score

The restoration score is used to identify those watersheds where data indicate the system is impaired. Due to the number of 11-digit HUCs and the lack of comprehensive monitoring data in each of the HUCs the restoration score for each HUC will be based on

the maximum of either a potential impacts score (PIS) or an observed impacts score (OIS). Mathematically, this relationship could be expressed as

$$\text{Restoration Score (RS)} = \text{MAX } \{\text{PIS, OIS}\}$$

1.3.3.1 Potential Impacts Score

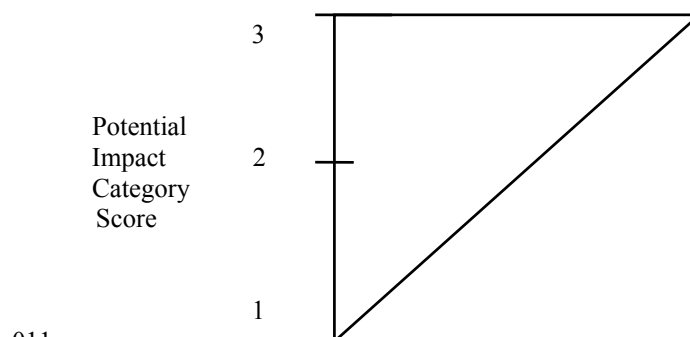
The potential impacts score for a particular watershed is computed as the weighted sum of the predicted impact scores for each individual impact category. The predicted impact categories include: 1) Flooding, 2) Supply Vulnerability 3) Drought Vulnerability, 4) Potential Contamination Sites (landfills, underground storage tanks, and hazardous waste sites), 5) Potential Pesticide Loading, 6) Potential Fertilizer Loading, 7) Agricultural Erosion Potential, 8) Livestock Operations, 9) Discharge Violations, 10) DOW Citizen Complaints, 11) Toxic Release Inventory Risk, 12) Population Projections, and 13) Unsewered Population, 14) Mining, and 15) Runoff Potential. Mathematically, the predicted impacts score can be expressed as:

$$\text{Potential Impacts Score (PIS)} = (a \cdot C1 + b \cdot C2 + \dots + o \cdot C15)$$

where a, b, ... o are coefficients whose sum is equal to one.

The predicted impacts score for each impact category is determined using a linear relationship between the category impact score and an associated category indicator score. The category impact score ranges from 1 to 3 while the category indicator score limits will be dependent upon the range of the associated category indicator. Example functions for the potential impact categories are shown in Figure 5.

Currently, the majority of the potential impact categories have been analyzed using county based data. As a result, the associated indicator scores are reflective of the range of values at the county level. In order to determine the associated 11-digit HUC scores, the county values have been disaggregated to the associated 11-digit HUCs using a GIS (Geographical Information System; e.g. ArcInfo, ArcView) (see Figure 6). The remaining potential impact categories (i.e. mining, and runoff potential) have been analyzed using an area-based weighted average approach similar to the approach used with the protection score categories (see Figure 4).



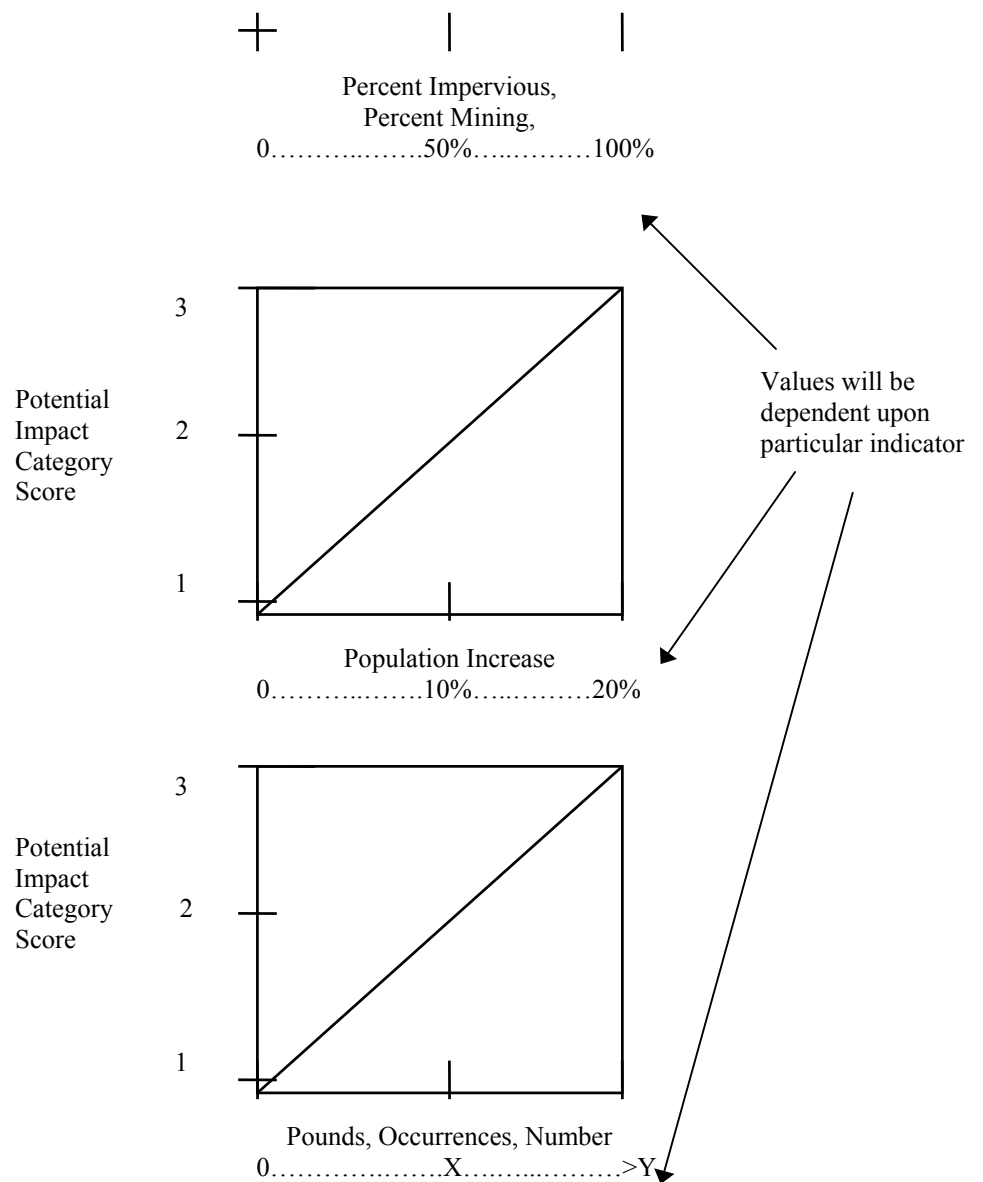
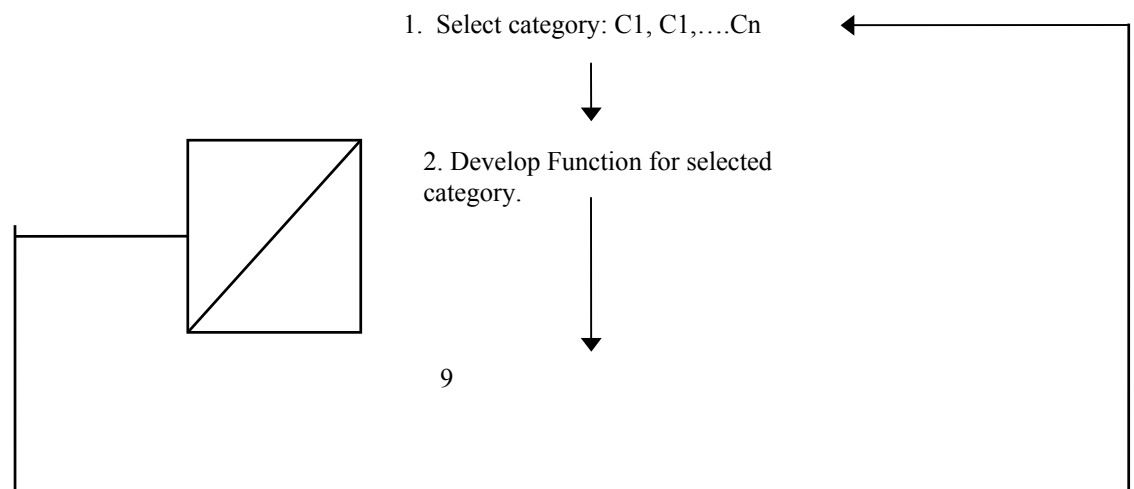


Figure 5. Functional Relationships for Potential Impact Categories



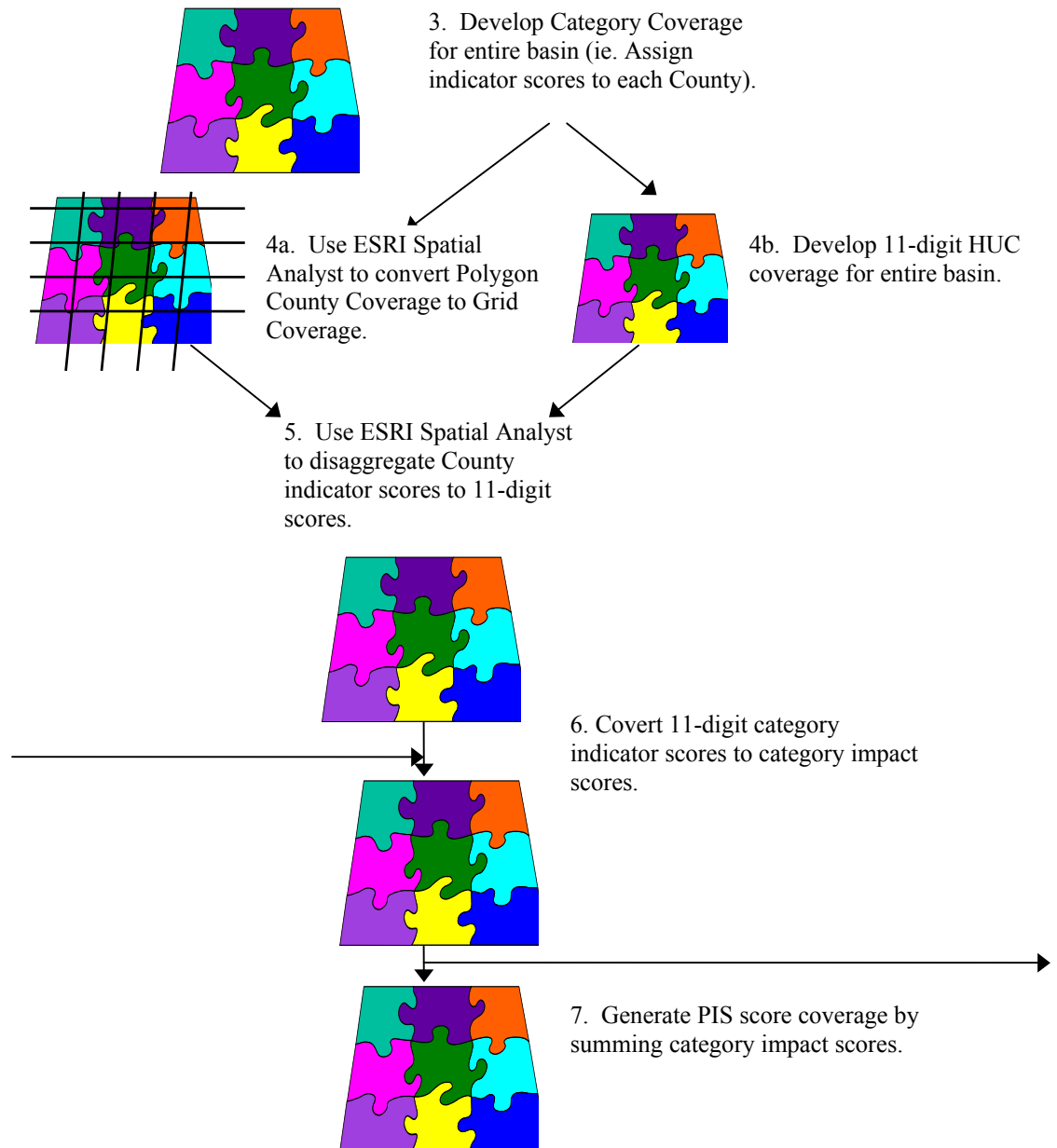


Figure 6. Potential Impact Score Development (County Data)

1.3.3.2 Observed Impact Score

The observed impacts score for a particular watershed will be computed as the sum of the observed impact scores for each individual impact indicator. The individual impact category scores are based on the maximum score of the associated sub-categories. The observed impact categories (with sub-categories in parenthesis) include: 1) Ecological Health (Aquatic life (AL), Contamination Sites (EHCS)), and 2) Human Health (Flooding (F), Supply Inadequacy (SI), Surface Drinking Water (SD), Groundwater

(GD), Contamination Sites (HHCS), Tissue Consumption (TC), and Primary Contact (PC)). Mathematically, the observed impact score is expressed as:

$$\text{Observed Impacts Score (OIS)} = \text{Eco. Health (MAX\{AL,EHCS\})} + \text{Human Health (MAX\{F,SI,SD,GD,HHCS,TC,PC\})}$$

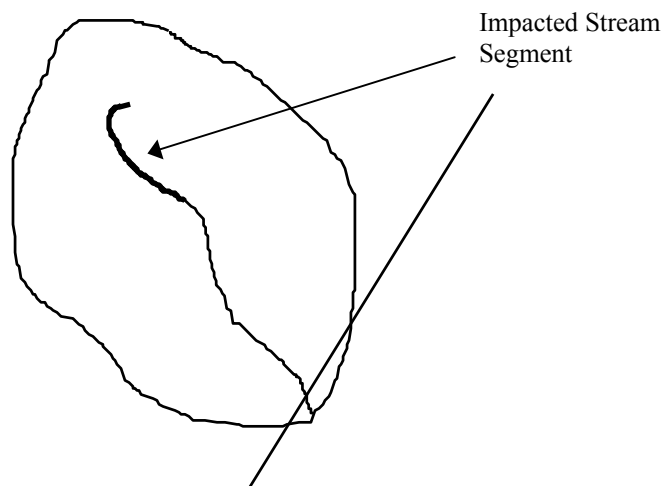
The observed impacts scores for each designated use sub-category will be generated using the following equation:

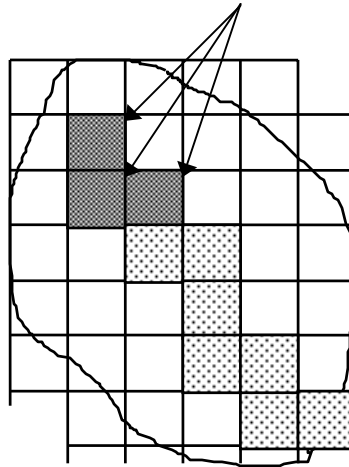
$$\begin{aligned} \text{Sub-category Impact Score (e.g. AL,SD,GD,TC,PC)} = & \\ & 1.0 * (\% \text{ of sub-category fully supporting (FS) designated use}) + \\ & 2.0 * (\% \text{ of sub-category partially supporting (PS) designated use}) + \\ & 3.0 * (\% \text{ of sub-category not supporting (NS) designated use}). \end{aligned}$$

where the percentage of a designated use category is based on the ratio of the length of streams of a particular designated use category to the total length of assessed streams for that particular 14-digit HUC. This process may be streamlined by converting the associated spatial or linear coverages into point values by rasterizing the associated vector data (See Figure 7). The final observed impact score can then be obtained by integrating the associated 14-digit coverages as shown in Figure 8.

1.3.4 GIS Utilization

Both the watershed prioritization phase and the subsequent targeting phase can be greatly facilitated through the use and application of geographic information system (GIS) technology. As discussed previously, GIS software can be used to evaluate and integrate the various geo-referenced data coverages that make up the independent variables associated with both the protection and restoration scores. By imbedding the various model parameters directly within the GIS, the GIS software can be used to provide a visual sensitivity analysis of the prioritization weights. Such a capability should provide a mechanism with which to finalize the associated model parameter values. In addition, by developing separate coverages for the various targeting criteria, GIS could also be used to integrate and visually evaluated various targeting strategies.



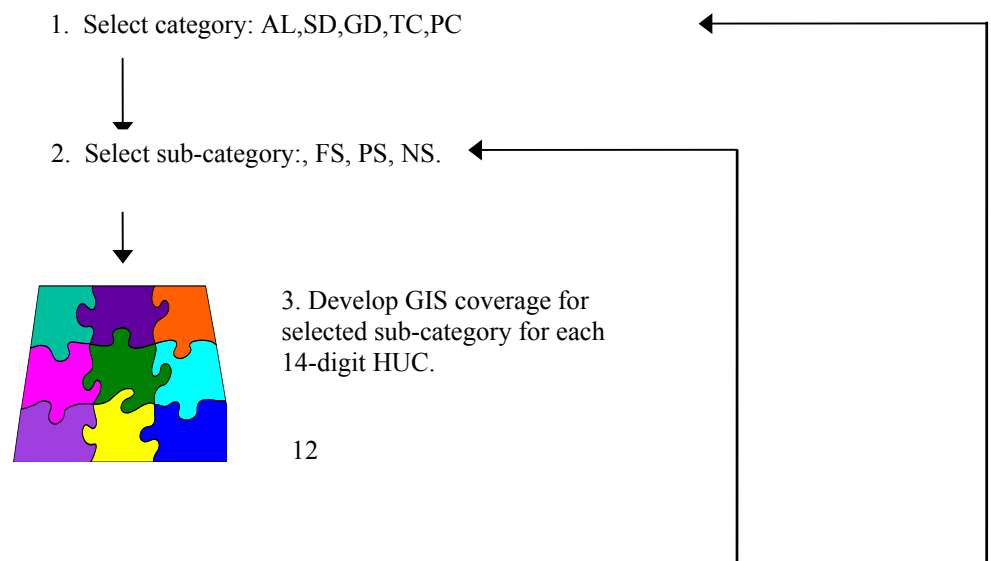


Percent of impacted
stream equals 3
cells divided by 10
cells or 30%.

Figure 7. Vector to Raster Conversion

1.3.5 GIS Coverages

In order to utilize GIS in the prioritization and targeting phase of the Basin Management Cycle, several GIS coverages will have to be developed or converted for use. The anticipated coverages for each of the prioritization goals are identified in Table 2.



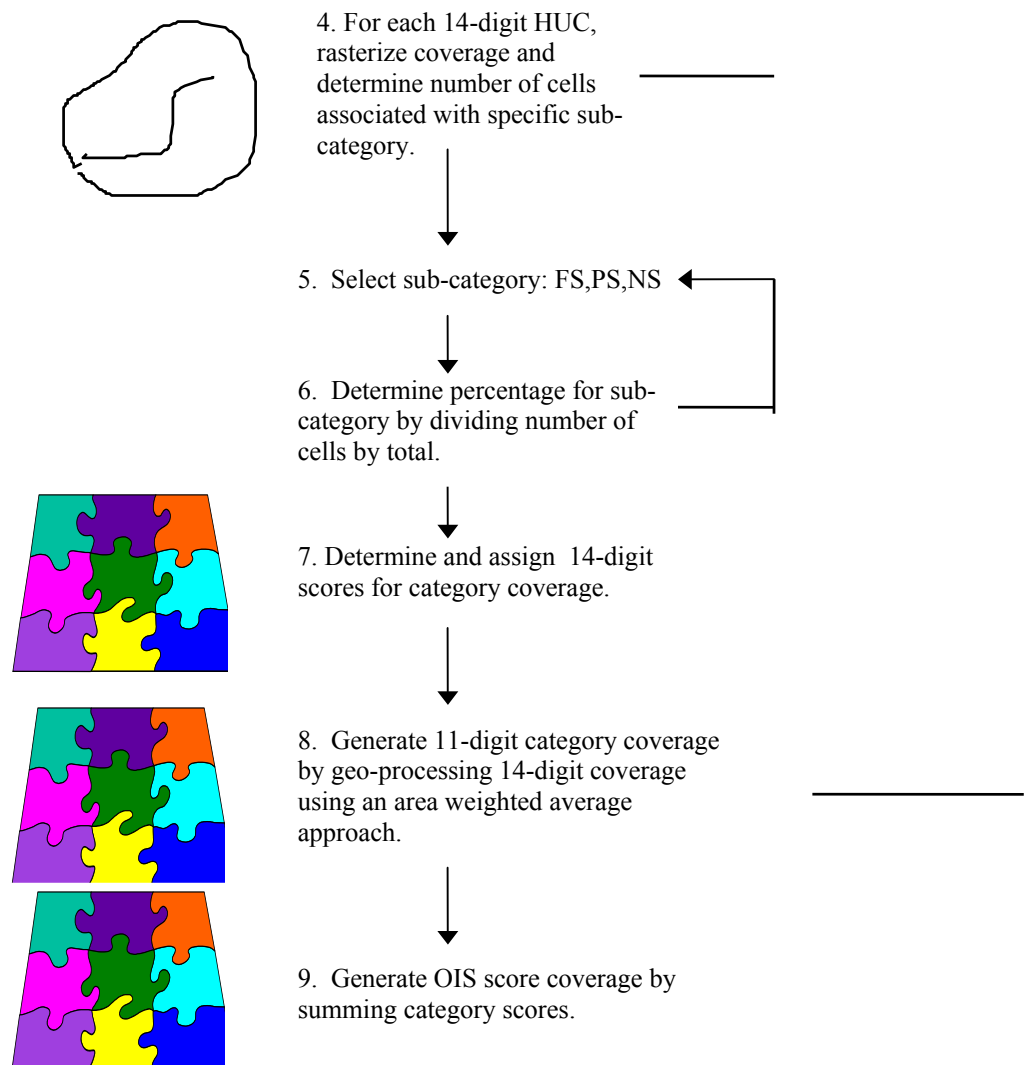


Figure 8. Observed Impacts Score Development (Designated Use Categories)

**Table 2:GIS Coverages
Protection Score Categories**

Category	Indicator	State Range	Coverage	Source/Contact	GIS Data Field
Wetlands	Normalized Area	0 - 40%	Polygon	OIS/DOW/John Dovak	Wetland(d)
Surface Drinking Water Areas	Normalized Area	0 - 100%	Polygon	DOW/David Morgan	NEED DATA
Well-head Protection Area (3 Tiers)	Normalized Area	0 - 100%	Polygon	DOW/Bruce McKinney	NEED DATA
Groundwater Sensitivity Zones (5 Levels)	Normalized Area	1 - 5	Polygon	DOW/Joe Ray	Sensitvy(d)
Fish/Wildlife Management Areas	Normalized Area	0 - 57%	Polygon	KYFW/Keith Wethington	Fwmng(d)
Nature Preserves Commission Areas	Normalized Area	0 - 12%	Polygon	NPC/Amy Covert	Npc(d)
Nature Conservancy Areas	Normalized Area	0 - 100%	Polygon	NC/Jeff Sole	Natcon(d)
US Forests	Normalized Area	0 - 100%	Polygon	OIS/Ken Bates	Usforest(d)
US Parks	Normalized Area	0 - 80.8%	Polygon	OIS/Ken Bates	Uspark(d)
State Forests	Normalized Area	0 - 56%	Polygon	OIS/Ken Bates	Stforest(d)
State Parks	Normalized Area	0 - 11%	Polygon	OIS/Ken Bates	Stpark(d)
Reference Reach Watersheds	Normalized Area	0 - 100%	Polygon	DOW/Greg Pond	Refreach(d)
Outstanding Resource Watersheds	Normalized Area	0 - 100%	Polygon	DOW/Scott Hankla	Orw(d)
Recognized Resources	Occurrence	0 - 8	Polyline	Kentucky Rivers Assessment	Recresc(d)
Kentucky River Assessments	Occurrence	0 - 25	Polyline	Kentucky Rivers Assessment	Rivasses(d)

Potential Impact Categories

Category	Indicator	State Range	Coverage	Source/Contact	GIS Data Field
Flooding Vulnerability	Value of Policies	0 - 134,157,000	County/City	DOW/Tim Brooks	Floodbul(d)
Supply Vulnerability	Vulnerability Score		County/City	DOW/David Morgan	Suppvul(d)
Drought Vulnerability	Vulnerability Score	1 - 3	County/City	DOW/David Morgan	Drgtvuln(d)
Potential Contamination Sites	Number of Sites	0 - 2,217	County	DWM/Kathy Scott, Linda Sherear, LeMoyné Pilcher	Potcontam(d)
Potential Pesticide Loading	Observed Sales (lbs)	0 - 36,227,768, 415	County	KYDA:DOP/Ernest Collins	Pesticid(d)
Potential Fertilizer Loading	Predicted Loading (lbs)	0 - 27,471,147	County	KASS Report/UK AGR-1	Fertiliz(d)
Agricultural Erosion Potential	Predicted Loading (tns)	.2 - 25.3	County	USDA-NRCS/Bob Eigel	Erosion(d)
Number of Cattle and Cows	Number/Type		County	KASS Report	Cattle(d)
Number of Hogs and Pigs	Number/Type		County	KASS Report	Hogs(d)
Number of Horses	Number/Type		County	KASS Report	Horse(d)
Livestock Operations(Animal Unit)	Number/Type	0 - 117,480	County	KASS Report	Lvstunt(d)
Discharge Violations	Number	1 - 1,000	Point	DOW/Vickie Prather	Discviol(d)
DOW Citizen Complaints	Number	0 - 209	County	DOW/Donna Drury	Compltns(d)
Toxic Release Inventory Risk	Number	0 - 40,377,584	Point	DOW/Alex Barber DES/Dave Falconer	Tri(d)
Population Projection	Population Increase	-1,706 - 4,766	Tract	US Census Bureau	Popchang(d)
Unsewered Population	Number	0 - 8,379	Tract	US Census Bureau	Unsewr(d)
Mining	Area	0 - 12.67%	Polygon	DSMRE/Darryl Hines	Mining(d)
CSOs	Number	0 - 121	Point	Herb Ray	Cso(d)
Runoff Potential	Curve Number	0 - 100%	Polygon	NRCS	FINISHING UP

Observed Impact Categories

Category	Indicator	Range	Coverage	Source/Contact	GIS Data Fields
HUMAN HEALTH					
Flooding	Insurance Claims	0 - 19,301,156	County/City	DOW/Tim Brooks	Flood(d)
Supply Inadequacy	Adequacy Score		County/City	DOW/David Mogan	Suppinad(d)
Designated Use:					
Surface Drinking Water	Use Support	0 - 3	Polyline	DOW/Tom VanArsdall	Dw(d)
Groundwater	Use Support	0 - 3	Point	DOW/Pete Goodman	NEED DATA
Tissue Consumption	Use Support	0 - 3	Polyline	DOW/Tom VanArsdall	Fc(d)
Primary Contact	Use Support	0 - 3	Polyline	DOW/Tom VanArsdall	Sw(d)
Contamination Sites	Number/Severity	0 - 241	Point	DWM/Kathy Scott, Linda Sherear, LeMoyne Pilcher, Herb Petitjean	Contamhh(d)
ECOLOGICAL HEALTH					
Designated Use					
Aquatic Life	Use Support	0 - 3	Polyline	DOW/Tom VanArsdall	Al(d)
Contamination Sites	Number/Severity	0 - 241	Point	DWM/Kathy Scott, Linda Sherear, LeMoyne Pilcher, Herb Petitjean	Contameh(d)

Protection Score Categories

- **Wetlands** – as defined and included in the US Fish & Wildlife wetlands inventory of 1983 to 1987 and digitized from 7.5 minute scale maps.
- **Surface drinking water protection areas** – areas delineated as a part of the Water Supply Planning and Protection efforts for the Division of Water; areas to be delineated for each public water supply using surface water as their source.
- **Well-head protection areas** --areas delineated as a part of the Water Supply Planning and Protection efforts for the Division of Water; areas to be delineated for each public water supply utilizing groundwater as their source.
- **Groundwater sensitivity zones** - areas delineated by the Division of Water and sub-divided into 5 protection classes.
- **Fish/Wildlife Management Areas** - those areas delineated and managed by Kentucky Fish and Wildlife.
- **Nature Preserves Commission Areas** - those management areas delineated and managed by the Kentucky Nature Preserves Commission.
- **Nature Conservancy Area** - those areas delineated by the Nature Conservancy.
- **Reference Reach Streams** - streams used to serve for baseline conditions as designated by the DOW.
- **Outstanding Resource Water** - those streams as designated by 401 KAR 5:031
- **Recognized Resources** - Those river corridors as designated by the 1992 Kentucky Rivers Assessment that include resources protected by federal or state laws and regulations or areas designated for their important resource values. Such resources include the following: 1) Rare species, 2) National natural landmark, 3) National parks, 4) Federal conservation area, and 5) University natural area.
- **River Assessments** - Those categories used in the 1992 Kentucky Rivers Assessment in which rivers in each category were assigned to one of three classes: 1) Superior, 2) Highly Significant, and 3) Significant. Categories include: 1) Agricultural lands, 2) Botanical resources, 3) Corridor character, 4) Cultural resources, 5) Fish resources, 6) Geologic and scenic features, 7) Recreational boating, 8) Water quality, 9) Water resources, 10) Wildlife resources.

Potential Impact Score

- **Flooding Vulnerability** – those counties or cities that have the potential for significant flooding as indicated by the total value of flood insurance policies.
- **Supply Vulnerability** - those counties or cities whose water supply system are potentially inadequate due to limitations in water supply or hydraulic infrastructure. The indicator score is based on projected inadequacies for the years 2005, 2010, and 2015 as obtained from the DOW water supply plans.
- **Drought Vulnerability** – those counties or cities that have been assessed for population and growth potential relative to the available water supply and treatment system, and that have the potential for shortfalls during periods of drought.
- **Potential contamination sites** – active underground storage tanks, hazardous waste facilities which have one or more Treatment, Storage, or Disposal units, landfills which were closed before the July 1992 deadline, illegal dumps, and large tire piles, brine wells, straight pipes; mostly county data.
- **Potential Pesticide Loading** – Kentucky Department of Agriculture - Division of Pesticides- 1996 pesticide sales database; sales by county.
- **Potential Fertilizer Loading** – Potential county wide fertilizer loadings obtained by multiplying the acres of various crop production by the average recommended fertilizer loading. Crop production estimates obtained from the Kentucky Agricultural Statistics Service annual report while recommended fertilizer loadings obtained from UK Cooperative Extension Service report AGR-1.

- **Potential Agricultural Erosion** – Tons of erosion as predicted using the USLE and reported by the US Department of Agriculture - National Resources Conservation Service - National Resources Inventory database for each county for cropland and pastureland uses.
- **Livestock operations** – number of head of livestock per county based on the Kentucky Agricultural Statistics Survey. Livestock include: cattle, and hogs and pigs.
- **Discharge violations** – a count of numeric violations of KPDES discharge violations (not including reporting violations).
- **DOW Citizen Complaints** – Complaints compiled by the Field Operations Branch of DOW
- **Toxic Release Inventory Risk** – usually 2-3 year old data reported to EPA by certain industries on specified toxic chemicals; this data is reported in pounds per parameter then adjusted with a toxic index potential value to weight data according to its known toxic effects.
- **Population projection** – projections from US Census Bureau data or U of L Data Center.
- **Unsewered Population** - total population unsewered or on septic systems, US Census Bureau
- **Mining** - Surface mining area per county.
- **Runoff Potential** – Runoff potential developed by computing a composite curve number for each 11-digit HUC by combining Anderson level II land cover categories and NRCS soil data.

Observed Impact Score

- **Human Health:**
 - Flooding: Observed flooding impacts as measured by the value of flooding insurance claims since 1978.
 - Supply Inadequacy: Those county or municipal systems that are currently inadequate based on either supply or hydraulic infrastructure and as reported in the DOW water supply plans.
 - Designated Use: the degree to which a stream segment meets its designated use: (Surface drinking water, tissue consumption, and primary contact) as reported in the bi-annual 305(b) report. The indicator for each sub-category is based on the following scoring: 3) does not support, 2) partially supporting, 1) fully supporting. For groundwater, use support system currently under development by DOW and KGS.
 - Soil and groundwater contamination sites – sites determined to be contaminated through the Division of Waste Management for landfills, USTs, State Superfund sites, and hazardous waste sites that have a potential human health impact.
- **Ecological health**
 - Designated Use: the degree to which a stream segment meets its designated use: (Surface drinking water, tissue consumption, and primary contact) as reported in the bi-annual 305(b) report. The indicator for each sub-category is based on the following scoring: 3) does not support, 2) partially supporting, 1) fully supporting.
 - Soil and groundwater contamination sites – sites determined to be contaminated through the Division of Waste Management for landfills, USTs, Superfund sites, and hazardous waste sites that have a potential human health impact.

1.4 Watershed Targeting

After the watersheds have been prioritized using the watershed priority formula, the next step will be to determine how to allocate resources to address the associated protection or restoration goals. Within each basin management unit, programs are expected to begin at the top of the watershed priority list and evaluate where to direct their resources based on the following types of criteria:

1.4.1 Public Support

This criteria involves assessing factors such as the degree of public interest, availability of local funding, and the degree of support by other resource agencies that are integral to implementation. Surveys could provide information on the degree of public support and local perception of problems. Documentation of existing groups (e.g. such as an active Waterways Alliance) and activities (e.g. such as proactive efforts by a water supply planning council) are examples of demonstrated public interest.

1.4.2 Manageability

Evaluating manageability could include such factors as feasibility of mitigating water quality problems or protecting the watershed, magnitude of cost, size of watershed, time necessary to correct problems, opportunity for success (e.g. ability of agencies to work together or capability to deal with the problem), amenability to available tools and controls, etc. Cost-benefit analyses (e.g. comparison of costs for treatment vs. BMPs for a given percentage reduction in nutrients) would provide valid feasibility comparisons.

1.4.3 Data Availability

Data may be sufficient to assess the watershed, but insufficient to quantify the problem for management purposes. If the problem cannot be quantified satisfactorily, then a data gap would be identified to be addressed in the future; information on gaps would also be shared with those responsible for updating annual monitoring strategies.

1.4.4 Program-Specific Funding

Managers should consider such elements as project funding eligibility (i.e., constraints regarding use of resources), and availability of funds for specific purposes. For example, the final priority list may contain a mix of point and non-point source pollution problems; however, 319 funds may only be targeted to areas to deal with nonpoint-source pollution problems.

1.4.5 Program Constraints

Program actions are limited by personnel and operational resources.

1.4.6 Goals

Resource allocations are constrained by federal, state, agency or basin management goals. Thus, a fixed amount of resources may need to be allocated to a variety of watershed types or for different program-specific areas (e.g., point source versus non-point source problems).

1.5 Classification Matrix

By cross-referencing the prioritization score and the targeting score for all watersheds a classification matrix may be constructed which can serve to provide guidance for the type of management activity appropriate for each individual watershed (see Figure 9). Watersheds falling into the “Implement” quadrant would be prime candidates for action plan development and implementation. The other quadrants, “prepare, build, and sustain,” provide an indication to programs and watershed residents of the types of activities that need to occur. Areas falling into the “prepare” quadrant are considered candidates for future action, with interim strategy focused on reducing barriers to implementation by increasing public awareness and/or increasing support among cooperators. Those with high probability of success but relatively low priority (i.e. “sustain” quadrant) are deferred, pending change in status or information. Those projects with low priority and low feasibility of success (i.e. “build” quadrant) may be deferred or targeted for awareness building, but to a lesser extent than other areas (KDOW, 1997).

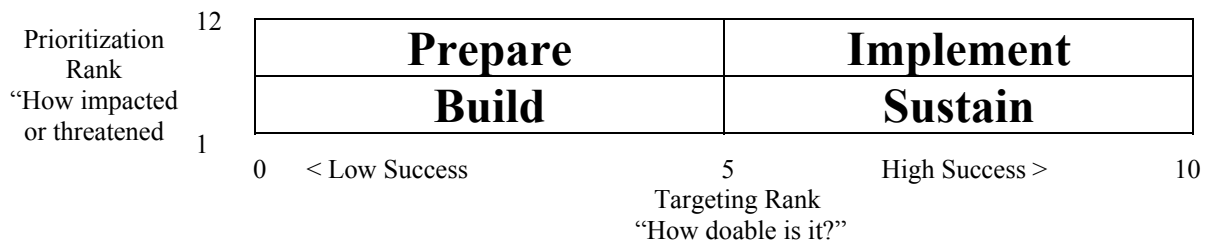


Figure 9. Watershed Classification Matrix
REFERENCES

1. Kentucky Division of Water, *Kentucky Watershed Management Framework*, (1997) Prepared by Tetra Tech, Inc., for the Kentucky Division of Water under contract no. PS970759.
2. Colten, Lee, (1997) *Watershed Priority Formula*, Internal Memo, Kentucky Division of Water, February 26, 1997.
3. Hankla, Scott, (1997) *Kentucky Rivers Assessment*, Kentucky Division of Water/National Park Service.
4. KYNREPC/KLTIRC (1996) *Kentucky Outlook 2000: A Strategy for Kentucky's Third Century: Technical Committee Reports*.
5. KYNREPC/DOW (1996) *1996 Kentucky Report to Congress on Water Quality*.

APPENDIX A. GIS COVERAGE METADATA

Protection Score Categories

1. Wetlands

Definition: Wetlands Areas as defined and included in the US Fish and wildlife wetlands inventory of 1983 to 1987 and digitized from 7.5 minute scale maps.

Indicator: Normalized Area

Range: 0-100%

Coverages: Polygon

Creator: Ken Bates, KYNREPC:OIS, 502-564-5174

Date: January 1998

Data Source: KYNREPC:OIS

Data Contact: Ken Bates, KYNREPC:OIS, 502-564-5174

Wetlands Contact: John Dovak , KYNREPC:DOW, 502-564-3410

Notes:

2. Surface Drinking Water Areas

Definition: Areas delineated as part of the Water Supply Planning and protection efforts for the Division of Water, areas to be delineated for each public water supply using surface water as their source.

Indicator: Normalized Area

Range: 0-100%

Coverages: Polygon (Upstream areas)/
Polygon (11 digit HUCs)/

Creator: Kimberly Prough, DOW, 502-564-3410

Date: Pending

Data Source: KYNREPC:DOW

Data Contact: David Morgan, KYNREPC:DOW, 502-564-3410

Notes: See 401 KAR 4:220 and KSWAPP

3. Well-head Protection Area (3 Tiers)

Definition: Areas delineated as part of the Water Supply Planning and protection efforts for the Division of Water, areas to be delineated for each public water supply using groundwater as their source.

Indicator: Normalized Area

Range: 0-100%

Coverages: Polygon (Wellhead areas)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/

Creator: Bruce McKinney, KYNREPC:DOW, 502-564-3410

Date: Pending

Data Source: KYNREPC:DOW

Data Contact: Bruce McKinney, KYNREPC:DOW, 502-564-3410

Notes:

4. Groundwater Sensitivity Zones (5 Zones)

Definition: Areas delineated by the Division of Water and sub-divided into 5 sensitivity classes.

Indicator: Normalized Area

Range: 0-100%

Coverages: Polygon (Sensitivity Zones)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/

Creator: Jim Currens, KGS, 606-257-5500
and Joe Ray, KYNREPC:DOW, 502-564-3410

Date: February 1998

Data Source: KYNREPC:DOW

Data Contact: Joe Ray, KYNREPC:DOW, 502-564-3410

Notes: Zone 5 represents karst regions most vulnerable to groundwater contamination.

5. Fish/Wildlife Management Areas

Definition: Those areas delineated and managed by Kentucky Fish and

Wildlife.
Indicator: Normalized Area
Range: 0-100%
Coverages: Polygon (management areas)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410
Date: January 1998
Data Source: KYF&WR
Data Contact: Keith Wethington, KYF&WR, 502-564-4406

Notes:

6. Nature Preserves Commission Management Areas

Definition: Those areas delineated and managed by the Kentucky Nature Preserves Commission as well as those proposed protection management areas within Daniel Boone National Forest.
Indicator: Normalized Area
Range: 0-100%
Coverages: Polygon (managed areas)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/
Creator: KNPC Data, Ted Stumbur, OIS, 502-573-1450
Daniel Boone, Jan Fry, DOW, 502-564-3410
Date: January 1998
Data Source: NPC
Data Contact: Amy Covert, NPC, 502-573-2886

Notes:

7. Nature Conservancy Area

Definition: Those areas delineated by the Nature Conservancy.
Indicator: Normalized Area

Range: 0-100%
Coverages: Polygon (delineated areas)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/
Creator:
Date: January 1998
Data Source: NC
Data Contact: Jeff Sole, TNC, 606-259-9655

Notes:

8. Reference Reach Stream

Definition: Streams used to serve as a reference for baseline biological conditions as designated by the DOW on the basis of their minimum level of impact.
Indicator: Upstream watershed area
Range: 0-100%
Coverages: Polygon (upstream areas)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410
Date: January 1998
Data Source: KYNREP:DOW
Database: ABIS-biological site locations
Data Contact: Greg Pond, KYNREPC:DOW, 502-564-3410

Notes: See 305(b) report.

9. Outstanding Resource Water

Definition: Those outstanding resource waters as designated by 401 KAR 5:031.
Indicator: Stream miles
Range: 0-100%

Coverage: Polygon (Upstream watersheds)/
 Polygon (11 digit HUCs)/
 Creator: Kimberly Prough, Jan Fry, Scott Hankla, DOW, 502-564-3410
 Date: January 1998
 Data Source: DOW
 Data Contact: Scott Hankla, DOW, 502-564-3410

Notes: As defined in 401 KAR 5:031. Stream mile points were linked to RF3 files.

10. Recognized Resources

Definition: Those river corridors as designated by the 1992 Kentucky Rivers Assessment that include resources protected by federal or state laws and regulations or areas designated for their important resource values. Such resources include the following: 1) rare species, 2) national natural landmark, 3) national park, 4) federal conservation area, and 5) university natural area.

Indicator: Occurrence
 Range: 0 - 5 depending upon the number of occurrences
 Coverages: Polyline (River segments)/
 Polygon (14-digit HUCs)/
 Polygon (11-digit HUCs)/
 Database: Occurrence Sheet from 1992 Kentucky River Assessment
 Creator: Beth Nordruft, Kimberly Prough, DOW, 502-564-3410
 Date: January 1998
 Data Source: 1992 Kentucky Rivers Assessment
 Data Contact: Scott Hankla, DOW, 502-564-3410

Notes: Category occurrence scores for each stream reach were imported into an EXCEL spreadsheet which was then linked to individual stream segments via ArcView. The scores for each segment were then linked to their corresponding 14-digit HUC by linking the stream coverage with the 14-digit coverage. 11-digit scores were then obtained using an area average of the corresponding 14-digit scores. Stream segment mile points were linked to RF3 files using dynamic segmentation.

11. Kentucky River Assessments

Definition: Those categories used in the 1992 Kentucky Rivers Assessment in which rivers in each category were assigned to one of three classes: 1) Superior, 2) Highly Significant, and 3) Significant. For the purpose of the protection score determination, only those rivers designated as superior were explicitly considered. Categories include: 1) Agricultural lands, 2) Botanical resources, 3) Corridor character, 4) Cultural resources, 5) Fish resources, 6) Geologic and

scenic features, 7) Recreational boating, 8) Water quality, 9) Water resources, 10) Wildlife resources.

Agricultural Lands: Study rivers with prime farmland, prime timberland, and farmable land.

Botanical Resources: Study rivers known to support at least one federal or state endangered plant species, or areas registered or eligible for national natural landmark, national park or other federal or state conservation area designation, or designated Kentucky Wild Rivers.

Corridor Character: Study rivers with primitive features with minimal visual intrusion into the landscape (eg. hiking trail, footbridge, un-maintained road) or with limited extent, short-term features (eg. picnic area, small boat dock, discharge pipe).

Cultural Resources: Study rivers with demonstrated clusters of historic and prehistoric archaeological sites or historic standing structures reflecting river-related life.

Fish Resources: Study rivers with federal listed species and/or Kentucky Academy of Science/Kentucky State Nature Preserves Commission list of endangered, threatened and rare animals of Kentucky; high-quality, cold water streams; or streams with potentially unique, native populations of muskellunge or walleye.

Geologic and Scenic Features: Study rivers with the occurrence of unique geologic features such as waterfalls, cascades, gorges, river terraces, and meander scars, or mineral springs.

Recreational Boating: Study rivers recognized as a prominent river recreation area by a publication or a statewide recreation organization or existing or potential use for canoeing, kayaking, rowing, or motorized boating.

Water Quality: Study waters which met one of the following minimum standards: 1) waters designated as Outstanding Resource Waters under 401 KAR 5:026, 2) water recommended for designation as Outstanding Resource Waters by the Kentucky State Nature Preserves Commission, and 3) waters recommended for designation as Outstanding Resource Waters by a qualified agency other than the Kentucky State Nature Preserves Commission.

Water Resources: Study waters which met one of the following minimum standards: 1) potential for future development as a water supply (lowest average monthly flow greater than or equal to 75 cubic feet per second or approximately 50 million gallons per day). 2) occurrence of developed hydropower sites or

undeveloped sites with identified potential for hydropower, and 3) commercially navigable rivers.

Wildlife Resources: Study waters which met criteria for habitat areas, threatened and endangered species, and corridor linkage.

Indicator:	Sum of category scores associated with each stream segment
Range:	0 - 30
Coverages:	Polyline (stream segments)/ Polygon (14-digit HUCs)/ Polygon (11-digit HUCs)/
Creator:	Kimberly Prough, DOW, 502-564-3410
Date:	January 1998
Source:	1992 Kentucky Rivers Assessment
Contact:	Scott Hankla, DOW, 502-564-3410
Notes:	Stream segment mile points were linked to RF3 files using dynamic segmentation.

Potential Impact Categories

1. Flooding

Definition: Those areas that are susceptible to flooding as indicated by the value of flood insurance policies.

Indicator: Value of Policies (\$)

Range:

Coverages: Polygon (County/Municipality)/
Grid (County/Municipality)/
Polygon (11-digit HUCs)/

Creator: Kimberly Prough, DOW, 502-564-3410

Date: December 1997

Data Source: DOW, NFIP Policy and Claims by County

Data Contact: Tim Brooks, DOW, 502-564-3410

Notes: Indicator scores were developed using NFIP Policy and Claim data obtained from the Water Resources Branch of the DOW. Database includes the value of flood insurance coverage for each county and municipality participating in the program. County data were synthesized using Grid and then disaggregated to the 11-digit HUCs. The total score for each 11-digit HUC was then augmented by adding the point values of the municipalities contained within each HUC.

2. Supply Vulnerability

Definition: Supply vulnerability (capacity and distribution) as measured over the next 20 years and as prescribed in 401 KAR 4:220

Indicator: Area Averaged Vulnerability score (0-3)

Range: 0-3

Coverages: Polygon (County/Municipality)/
Grid (County/Municipality)/
Polygon (11-HUCs)/

Creator: Kimberly Prough, DOW, 502-564-3410

Date: April 1998

Data Source: DOW

Data Contact: Dionne Fields, DOW, 502-564-3410

Notes: Vulnerability scores were based on the number of years until the system would be vulnerable: 5-10 yrs (3), 10-15 years (2), 15-20 yrs (1). The indicator score for each HUC is obtained by multiplying the vulnerability score times the percent area of the total HUC area contained in the system service area.

3. Drought Vulnerability

Definition: Those areas that are vulnerable to drought as measured by a drought vulnerability index.
 Indicator: Drought susceptibility index
 Range: (0-2)
 Coverages: Polygon (County)/
 Polygon (14-digit HUCs)/
 Polygon (11-digit HUCs)/
 Creator: Kimberly Prough, DOW, 502-564-3410
 Date: November 1997
 Data Source: DOW
 Data Contact: David Morgan, DOW, 502-564-3410

 Notes: Drought vulnerability score based on DOW database of County vulnerability: 0 - no vulnerability, 1 - moderate vulnerability, 2- significant vulnerability.

4. Potential Contamination Sites

Definition: Active underground storage tanks, hazardous waste facilities which have one or more Treatment, Storage, or Disposal units, landfills which were closed before the July 1992 deadline.
 Indicator: Number
 Range: 0-2217
 Coverages: Polygon (County)/
 Grid (County)/
 Polygon (11-digit HUCs)/
 Creator: Kimberly Prough, DOW, 502-564-3410
 Date: September 1997
 Data Source: KYNREPC:DWM
 Data Contact: DWM, UST, Kathy Scott, 502-564-6176
 DWM, RCRIS, Linda Sherear, 502-564-6176

Notes:

5. Potential Pesticide Loading

Definition: Total observed sales by county, measured in pounds.

Indicator: Pounds
 Range:
 Coverages: Polygon (County)/
 Grid (County)/
 Polygon (11-digit HUCs)/
 Creator: Kimberly Prough, DOW, 502-564-3410
 Date: September 1997
 Data Source: KYDA,DOP
 Data Contact: Ernest Collins, DOP, 502-564-7274

Notes:

6. Potential Fertilizer Loading

Definition: Tons of fertilizer applied to each county
 Indicator: Tons
 Range:
 Coverages: Polygon (County)/
 Grid (County)/
 Polygon (11-digit HUCs)
 Creator: Kimberly Prough, DOW, 502-564-3410
 Date: December 1997
 Data Source: UKES 1996-97 Fertilizer Recommendations (AGR-1)
 1996-97 Kentucky Agricultural Statistics
 Data Contact: UK Agricultural Distribution Center: 606-257-7571
 KASS: 502-582-5293

Notes: Estimate of fertilizer loadings per county obtained by multiplying the number of acres per county of each crop (from KASS) by the recommended loading per crop of fertilizer (UKES). Result computed in a spreadsheet and then converted to a county based loading coverage. County based values were then disaggregated using Spatial Analyst. Grid values were then aggregated back to 11-digit HUC values using ArcView.

7. Potential Agricultural Erosion

Definition: Tons of erosion as predicted by the revised USLE (RUSLE) and reported by the US Department of Agriculture - Natural Resources

conservation Service - National Resources Inventory database for each county for cropland and pastureland uses.

Indicator: Tons per County
Range:
Coverages: Polygon (County)/
Grid (County)/
Polygon (11-digit HUCs)/
Creator: Kimberly Prough, 502-564-3410
Date: Decmeber 1997
Data Source: USDA-NRCS
Data Contact: Bob Eigel, NRCS, 606-224-7357 NRI data

Notes: Climate Data Liaison: Bill Waits, NRCS, 606-224-7354
RUSLE: David Stipes KY State Agronomist, 606-224-7392

8. Livestock Operations

Definition: Number of livestock per county
Indicator: Equivalent Animal Units
Range:
Coverages: Polygon (County)/
Grid (County)/
Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410
Date: October 1997
Data Source: 1996-97 Kentucky Agricultural Statistics(Cattle, Hogs)
Data Contact: Robert Thurston, Dan Lofthuf KASS:502-582-5293

Notes: Separate livestock coverages per county were developed for Cattle, Hogs, and Horses, converted to equivalent animal units and then combined.

9. Discharge Violations

Definition: A count of KPDES discharge violations (not including reporting\ violations)
Indicator: Number

Range: 1-1000
Coverages: Point (Discharge points/violations)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410
Date: September 1997
Data Source: PCS:KPDES permits
Data Contact: Vickie Prather, DOW, 502-564-3410

Notes:

10. DOW Citizen Complaints

Definition: Complaints compiled by the Field Operations Branch of DEP
Indicator: Number
Range: 0-209
Coverages: Polygon (County)/
Grid (County)/
Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410
Date: September 1997
Data Source: DOW
Data Contact: Donna Drury, DOW, 502-564-3410
Linda Howard, DWM, 502-564-6716 ext. 680
Melody Barker, DAQ, 502-564-3382 ext. 353

Notes:

11. Toxic Release Inventory Risk Score

Definition: Data reported to EPA by certain required industries on specified toxic chemicals; this data is reported in pounds per parameter and then adjusted with a toxic index potential value (EPA 1993) to

weight data according to its known potential toxic effects.

Indicator: Risk Value
 Range: 1-40,377,584
 Coverages: Point (location/score)/
 Polygon (14-digit HUCs)/
 Polygon (11-digit HUCs)/
 Creator: Kimberly Prough, DOW, 502-564-3410
 Date: October 1997
 Data Source: EPA
 Data Contact: Alex Barber, DOW, 502-564-3410
 David Falconer, DES, 502-564-6120

Notes:

12. Population Projection

Definition: Population projections from US Census Bureau data or
 UL Data Center.

Indicator: Population Increase in Persons/Area
 Range: -2129-13,587
 Coverages: Polygon (Census Tract)/
 Grid (Census Tract)/
 Polygon (14-digit HUCs)/
 Polygon (11-digit HUCs)/
 Creator: Kimberly Prough, DOW, 502-564-3410
 Date: November 1997
 Data Source: U.S. Census Bureau
 Data Contact: Kimberly Prough, DOW, 502-564-3410

Notes:

13. Unsewered Population

Definition: Total population unsewered or on septic systems
 Indicator: Number of People
 Range: 900-39772
 Coverages: Polygon (Census Tract)/
 Grid (Census Tract)/
 Polygon (14-digit HUCs)/

Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410
Date: November 1997
Data Source: U.S. Census Bureau
Data Contact: Kimberly Prough, DOW, 502-564-3410

Notes:

14. Mining

Definition: Surface mining area per county
Indicator: Acres
Range:
Coverage: Points (Mining areas)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410
Date: February 1998
Data Source:
Data Contact: Darryl Hines, Fred Craig, DSMRE, 502-564-6940

Notes:

15. Runoff Potential

Definition: Potential runoff as measured by composite NRCS composite runoff coefficient as computed as a function of landuse and soil type.
Indicator: Composite runoff curve number for each HUC.
Range: 0-100
Coverages: Polygon (landuse)/
Grid (landuse)/

Polygon (soiltype)/
Grid (soiltype)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410
Date: Pending
Data Source: Land Use Data: Murray State University
Soil Data: NRCS
Data Contact: NRCS

Notes:

Observed Impacts Categories

Human Health

1. Flooding

Definition: Observed flooding impacts as measured by the value of flooding insurance claims since 1978.

Indicator: Value of Claims (\$)

Range:

Coverages: Polygon (County/Municipality)/
Grid (County/Municipality)
Polygon (11-digit HUCs)/

Creator: Kimberly Prough, DOW, 502-564-3410

Date: February 1998

Data Source: NFIP Policy and Claims by County

Data Contact: Tim Brooks, DOW, 502-565-3410

Notes: Indicator scores were developed using NFIP Policy and Claim data obtained from the Water Resources Branch of the DOW. Database includes the value of flood insurance claims for each county and municipality participating in the program. County data were synthesized using Spatial Analyst and then aggregated to the 11-digit HUCs. The total score for each 11-digit HUC was then augmented by adding the point values of the municipalities contained within each HUC.

2. Supply Inadequacy

Definition: Those counties or municipal systems that are currently inadequate based on either supply or hydraulic infrastructure as reported in the DOW water supply plans.

Indicator: Adequacy Score

Range:

Coverages: Polygon (County/Municipality)/
Grid (County/Municipality)/
Polygon (11-digit HUCs)/

Creator: Kimberly Prough, DOW, 502-564-3410

Date: Pending

Data Source: DOW water supply plans

Data Contact: David Morgan, DOW, 502-565-3410

Notes: See 401 KAR 4:220

3. Surface Drinking Water

Definition: The degree to which a surface water stream meets is designated use (i.e. drinking water supply) for drinking water standards pursuant to 401 KAR 5:031 and as reported as reported in the Kentucky bi-annual 305(B) report.

Indicator: Use Support: 3) does not support, 2) partially supporting, 1) fully supporting

Range: 1-3

Coverages: Polyline (stream segments)/

Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410
Date: January 1998
Data Source: 1997 305b Report
Data Contact: Tom VanArsdall, DOW:502-565-3410

Notes:

4. Ground Drinking Water

Definition: The degree to which a ground drinking water system meets uses.
Indicator: Use Support
Range: 1-3
Coverages: Point (location/support)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410
Date: Pending
Data Source: KGS
Data Contact: Pete Goodman, DOW, 502-564-3410

Notes: Designated use system for groundwater is still under development by DOW Groundwater Branch and KGS.

5. Tissue Consumption

Definition: The degree to which a surface water stream meets is designated use for tissue consumption pursuant to 401 KAR 5:031 and as reported in the Kentucky bi -annual 305(B) report.
Indicator: Use Support: 3) does not support, 2) partially supporting, 1) fully supporting
Range: 1-3
Coverages: Polyline (stream segments)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410

Date: January 1998
Data Source: 1997 305b Report
Data Contact: Tom VanArsdall, DOW:502-564-3410

Notes:

6. Primary Contact

Definition: The degree to which a surface water stream meets is designated use for primary contact (i.e. swimming) pursuant to 401 KAR 5:031 and as reported in the Kentucky bi-annual 305(B) report.

Indicator: Use Support: 3) does not support, 2) partially supporting, 1) fully supporting

Range: 1-3

Coverages: Polyline (stream segments)/
Polygon (14-digit HUCs)/
Polygon (11-digit HUCs)/

Creator: Kimberly Prough, DOW, 502-564-3410

Date: January 1998

Data Source: 1997 305b Report

Data Contact: Tom VanArsdall, DOW:502-564-3410

Notes:

7. Contamination Sites

Definition: Soil and groundwater contamination sites - sites determined to be contaminated through the Division of Waste Management for landfills, UST's, Superfund sites, and hazardous waste sites that have a potential human health impact.

Indicator: Number/Severity

Range:

Coverages: Polygon (County)/
Grid (County)/
Polygon (11-digit HUCs)/

Creator: Kimberly Prough, DOW, 502-564-3410

Date: January 1998
Data Source: KYNREPC:DWM
Data Contact: DWM, UST, Kathy Scott, 502-564-6716
DWM, RCRIS, Brian Baker, 502-564-6716
DWM, Superfund, CERCLIS, Herb Petitjean, 502-564-6716
DWM, Solid Wastes, LeMoyne Pilcher, 502-564-6716

Notes: Landfills >1 acre only residential
Superfund Sites = state superfund sites, active and closed (not "non incident")

Ecological Health

1. Aquatic Life

Definition: The degree to which a surface water stream meets is designated use for aquatic life pursuant to 401 KAR 5:031 and as reported in the Kentucky bi-annual 305(B) report.
Indicator: Use Support: 3) does not support, 2) partially supporting, 1) fully supporting
Range: 1-3
Coverages: Polyline (stream segments)/
Polygon (14-digit HUCs)/

Polygon (11-digit HUCs)/
Creator: Kimberly Prough, DOW, 502-564-3410
Date: January 1998
Data Source: 1997 305b Report
Data Contact: Tom VanArsdall, DOW:502-564-3410

Notes:

2. Contamination Sites

Definition: Soil and groundwater contamination sites - sites determined to be contaminated through the Division of Waste Management for landfills, UST's, Superfund sites, and hazardous waste sites that have a potential human health impact.

Indicator: Number/Severity

Range:

Coverages: Polygon (County)/
Grid (County)/
Polygon (11-digit HUCs)/

Creator: Kimberly Prough, DOW, 502-564-3410

Date: January 1998

Data Source: Data Source: DWM

Data Contact: DWM, UST, Kathy Scott
DWM, RCRIS, Linda Sherear
DWM, Superfund, Herb Petitjean
DWM, Solid Wastes, LeMoyne Pilcher, 502-564-6176

Notes:

APPENDIX B: GIS COVERAGE CONSTRUCTION GUIDELINES

In developing the various GIS coverages for use in the Kentucky Watershed Priority Formula, three major types of data sources were considered: county data, census tract data, and point data. Guidelines for using Arcview to construct the associated 11-digit HUC coverages are provided in the following sections:

COUNTY DATA-(Flooding Vulnerability, Supply Vulnerability, Drought Vulnerability, Potential Contamination Sites, Pesticides, Fertilizer, Agricultural Erosion Potential, Livestock Operations, DOW Citizen Complaints, Flooding Observed, Supply Inadequacy, Contamination Sites[Human Health and Ecological Health])

1. Join the County coverage table with the raw data table using the county name as the join field.
2. Obtain the density per county by dividing the raw data value by the square miles of each county.

3. Use the Convert to Grid option under the Theme menu to convert the County coverage to a Raster Image using the raw data field.
4. Use the Summarize Zones option under the Analysis menu to summarize the value of each 11 digit HUC. This results in a statistics table which gives a value to each 11 digit HUC.
5. Create a new field in the statistics table with the actual value per 11 digit HUC by multiplying the square miles of each HUC by the mean value.
6. Delete all the fields in the statistics table except the HUC 11 field and the new field.
7. Join the statistics table to the 11 digit HUC composite table which contains the values for each category.
8. Join the 11 digit HUC composite table with the 11 digit HUC coverage.
9. Categorize the 11 digit HUC coverage based on the new data field.

Coverages: County, Grid, 11 digit HUC

CENSUS DATA-(Population Projection, Unsewered Population)

1. Join the Census Tract coverage table with the raw census data table using the fips code as the join field.
2. Obtain the density per census tract by dividing the raw data value by the square miles of each census tract.
3. Use the Convert to Grid option under the Theme menu to convert the Census Tract coverage to a Raster Image using the raw data field.
4. Use the Summarize Zones option under the Analysis menu to summarize the value of each 14 digit HUC. This results in a statistics table which gives a value to each 14 digit HUC.
5. Create a new field in the statistics table with the actual value per 14 digit HUC by multiplying the square miles of each HUC by the mean value.
6. Delete all the fields in the statistics table except the HUC 14 field, the HUC11 field, and the new field.
7. Join the statistics table to the 14 digit HUC composite table which contains the values for each category.
8. Join the 14 digit HUC composite table with the 14 digit HUC coverage.
9. Categorize the 14 digit HUC coverage based on the new data field.
10. Use the summarize button on the 11 digit HUC field and add the sum of the raw data column. This creates a summary table which assigns the raw data information to each 11 digit HUC.
11. Join the summary table to the 11 digit HUC composite table which contains the values for each category.
12. Join the 11 digit HUC composite table with the 11 digit HUC coverage.
13. Categorize the 11 digit HUC coverage based on the raw data field.

Coverages: Census Tracts, Grid, 14 digit HUC, 11 Digit HUC.

POINT DATA-(Toxic Release Inventory, Discharge Violations, CSOs)

1. Bring in a dbase or text file with latitude and longitude and create a Shapefile from the table. This is done by choosing the Add Event Theme option from the View menu. Choose the longitude field for the X field and latitude for the Y field.
2. Do a spatial join to assign a 14 digit HUC value to each point. First, activate the point table and select the "Shape" field then activate the 14 digit HUC table and highlight the "Shape" field and join the two tables.
3. Use the summarize button on the 14 digit HUC field, add the first 11 digit HUC, and add the sum of the raw data column. This creates a summary table which assigns the raw data information to each 14 digit HUC.
4. Join the summary table to the 14 digit HUC composite table which contains the values for each category.
5. Join the 14 digit HUC composite table with the 14 digit HUC coverage.
6. Categorize the 14 digit HUC coverage based on the raw data field.
7. Use the summarize button on the 11 digit HUC field and add the sum of the raw data column. This creates a summary table which assigns the raw data information to each 11 digit HUC.
8. Join the summary table to the 11 digit HUC composite table which contains the values for each category.
9. Join the 11 digit HUC composite table with the 11 digit HUC coverage.
10. Categorize the 11 digit HUC coverage based on the raw data field.

Coverages: Point, Grid, 14 digit HUC, 11 digit HUC.

POLYGON DATA-(Wetlands, Surface Drinking Water Areas, Well-head Protection Areas, Groundwater Sensitivity Zones, Fish/Wildlife Management Areas, Nature Preserves Commission Areas, Nature Conservancy Areas, US Forest Areas, US Park Areas, State Forest Areas, State Parks)

1. Intersect Polygon coverage with 14 digit HUC coverage. After the intersect is done the new polygon coverage contains information about which 14 and 11 digit HUC the polygon is located in (such as the code, area, etc...).
2. Calculate the area of the polygons in the coverage after the intersect.
3. Add a field to calculate percent area.
4. Use the calculate button to calculate the percent area by dividing polygon area by the total 14 digit HUC area.
5. Use the summarize button on the 14 digit HUC field and add the sum of the percent area. This creates a summary table which assigns a percent area value to each HUC.
6. Join the summary table to the 14 digit HUC composite table which contains the values for each category.
7. Join the 14 digit HUC composite table with the 14 digit HUC coverage.
8. Categorize the 14 digit HUC coverage based on the raw data field.
9. Use the summarize button on the 11 digit HUC field and add the sum of the raw data column. This creates a summary table which assigns the raw data information to each 11 digit HUC.
10. Join the summary table to the 11 digit HUC composite table which contains the values for each category.
11. Join the 11 digit HUC composite table with the 11 digit HUC coverage.

12. Categorize the 11 digit HUC coverage based on the raw data field.

Coverages: Polygon, 14 digit HUC, 11 Digit HUC.

POLYLINE DATA(Occurance)-(Recognized Resources)

1. For each 11 Digit HUC determine the number of occurrences of recognized resources (ranges from 0 - 8). Create a table with the 11 Digit HUC codes and assign each HUC a number based on the number of occurrences.
2. Join the new table with the 11 digit HUC composite table.
3. Join the 11 digit HUC composite table with the 11 digit HUC coverage.
4. Categorize the 11 digit HUC coverage based on the raw data field.

Coverages: Polyline, 11 Digit HUC.

POLYLINE DATA(Surface Drinking Water, Groundwater, Tissue Consumption, Primary Contact, Aquatic Life, Kentucky River Assessments)

1. Intersect Designated Use coverage with 14 digit HUC coverage. After the intersect is done the new polyline coverage contains information about the 14 and 11 digit HUC the polyline is located in (such as the code, area, etc...).
2. Calculate the length for each designated use segment.
3. Select all of the designated use segments for a certain category. For example, choose all segments with a drinking water designated use greater than 0.
4. Use the summarize button on the 14 digit HUC field, and add the sum of the segment length (calculated in step 2) and the average of the associated score. This creates a summary table that assigns a designated use stream length and score to each 14 digit HUC.
5. Use the Summarize button on the 14 digit HUC field and add the sum of the segment length (field is called length). This creates a summary table which sums up the length of all stream segments in each HUC to give the length of all the stream segments in each 14 digit HUC. Note: this step needs only to be done one time. The summary table with the length of all the stream segments in each 14 digit HUC will be used for all the polyline use support data.
6. Join the 2 summary tables (created in step 4 and step 6). Start editing the joined table and add a new field (number, 4 decimals). Select the new field and use the map calculator to multiply the stream segment length by the score and divide this number by the total length of all assessed streams in the 14 digit HUC (i.e. (segment length*score)/length of all streams in HUC).
7. Join the joined table (Joined in step 7) to the 14 digit HUC composite table which contains the values for each category.
8. Join the 14 digit HUC composite table with the 14 digit HUC coverage table which gives each HUC a raw data value.
9. Categorize the 14 digit HUC coverage based on the raw data field.

10. Use the summarize button on the 11 digit HUC field and add the sum of the raw data column. This creates a summary table which assigns the raw data information to each 11 digit HUC.
11. Join the summary table to the 11 digit HUC composite table which contains the values for each category.
12. Join the 11 digit HUC composite table with the 11 digit HUC coverage.
13. Categorize the 11 digit HUC coverage based on the raw data field.

Coverages: Polyline, 14 digit HUC, 11 Digit HUC.

POLYLINE DATA(Normalized Area)-(Reference Reach Watersheds, Outstanding Resource Waters)

1. Intersect the coverage with the 14 digit HUC coverage. After the intersect is done the new polyline coverage contains information about the 14 and 11 digit HUC each polyline is located in (such as the code, area, etc...).
2. Zoom in to a stream segment designated reference reach or outstanding resource waters and select it (if the segment is in multiple 14 digit HUCs only choose the part of it in 1 HUC).
3. Bring up the 14 digit HUC table and use the Statistics command under the Field menu to obtain the total area of the selected 14 digit HUCs and record the area.
4. Close the table and use the identify button to determine which 11 digit HUC the selected segment is in and select all polygons with that 11 digit HUC. Use the Statistics command under the Field menu to obtain the total area of the entire 11 digit HUC, write down the total area and the code of the selected 11 digit HUC.
5. Create a new table. Start Editing the new table and add a field called HUC11(string, 16 characters), a field called segarea(number, 4 decimals), a new field called hucarea(number, 4 decimals).
6. The HUC11 field will contain the 11 digit HUC code(recorded in step 4), the segarea field will contain the area of the recognized resource or outstanding resource water (recorded in step 3), and the h11area field will contain the area of the entire 11 digit HUC (recorded in step 4).
7. Choose the Add Records command from the Edit menu and type in the 11 digit HUC number, the recognized resource or outstanding water resource area, and the 11 digit HUC area in the correct fields.
8. Add a field and calculate the percent area in the 11 digit HUC. To do this use the map calculator to divide the resource area field by the h11area field. i.e. $\text{segarea}/\text{h11area}$.
9. Return to the view, zoom to a new segment and begin at step 3.
10. Once you have all the HUCs and areas entered into the table choose Stop Editing from the Table menu and save the changes.
11. Join the new table to the 11 digit HUC composite table which contains the values for each category.
12. Join the 11 digit HUC composite table with the 11 digit HUC coverage table which gives each HUC a raw data value.
13. Categorize the 11 digit HUC coverage based on the raw data field.

Coverages: Polyline, 14 digit HUC, 11 Digit HUC.